IS-005 <Invited Talk>

Unusual ALD Behaviors in Functional Oxide Films for Semiconductor Memories

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Atomic layer deposition (ALD) is known for its self-limiting reaction, which offers atomic-level controllability of the growth of thin films for a wide range of applications. The self-limiting mechanism leads to very useful properties, such as excellent uniformity over a large area and superior conformality on complex structures. These unique features of ALD provide promising opportunities for future electronics. Although the ALD of Al_2O_3 film (using trimethyl-aluminum and water as a metal precursor and oxygen source, respectively) can be regarded as a representative example of an ideal ALD based on the completely self-limiting reaction, there are many cases deviating from the ideal ALD reaction in recently developed ALD processes. The nonconventional aspects of the ALD reactions may strongly influence the various properties of the functional materials grown by ALD, and the lack of comprehension of these aspects has made ALD difficult to control. In this respect, several dominant factors that complicate ALD reactions, including the types of metal precursors, non-metal precursors (oxygen sources or reducing agents), and substrates, will be discussed in this presentation. Several functional materials for future electronics, such as higher-k dielectrics (TiO_2, $SrTiO_3$) for DRAM application, and resistive switching materials (NiO) for RRAM application, will be addressed in this talk. Unwanted supply of oxygen atoms from the substrate or other component oxide to the incoming precursors during the precursor pulse step, and outward diffusion of substrate atoms to the growing film surface even during the steady-state growth influenced the growth, crystal structure, and properties of the various films.

Keywords: ALD

IS-006 <Invited Talk>

Atomic Layer Deposition for Energy Devices and Environmental Catalysts

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In this talk, I will briefly review recent results of my group related to application of atomic layer deposition (ALD) for fabricating environmental catalysts and organic solar cells. ALD was used for preparing thin films of TiO_2 and NiO on mesporous silica with a mean pore size of 15 nm. Upon depositing TiO_2 thin films of TiO_2 using ALD, the mesoporous structure of the silica substrate was preserved to some extent. We show that efficiency for removing toluene by adsorption and catalytic oxidation is dependent of mean thickness of TiO_2 deposited on silica, i.e., fine tuning of the thickness of thin film using ALD can be beneficial for preparing high-performing adsorbents and oxidation catalysts of volatile organic compound. NiO/silica system prepared by ALD was used for catalysts of chemical conversion of CO_2. Here, NiO nanoparticles are well dispersed on silica and confiend in the pore, showing high catalytic activity and stability at $800^{o}C$ for CO_2 reforming of methane reaction. We also used ALD for surface modulation of buffer layers of organic solar cell. TiO_2 and ZnO thin films were deposited on wet-chemically prepared ZnO ripple structures, and thin films with mean thickness of ~2 nm showed highest power conversion efficiency of organic solar cell. Moreover, performance of ALD-prepared organic solar cells were shown to be more stable than those without ALD. Thin films of oxides deposited on ZnO ripple buffer layer could heal defect sites of ZnO, which can act as recombination center of electrons and holes.

Keywords: Atomic layer deposition, volatile organic comound, CO_2 reforming, orgnic solar cell